



March 13, 2008

Secretary Mike Chrisman  
Resources Agency  
1416 Ninth Street, Suite 1311  
Sacramento, California 95814

Dear Secretary Chrisman:

Dr. Jeffrey P. Fisher, a marine environmental scientist and principal with Environ International Corporation, has prepared the attached document, on behalf of the Pacific Coast Shellfish Growers Association, in response to the Report entitled "Potential Impacts of Mariculture Activities in the MLPA North Central Coast Study Region" (January 17, 2008 revised draft) ("The SAT Report"). The SAT Report was prepared as part of the California Marine Life Protection Act Initiative. As noted in my letter to you dated February 20, 2008, the supposed environmental impacts of shellfish culture called out in the SAT Report are both factually and scientifically erroneous in a number of respects. The attached document discusses those errors in detail.

We believe that the flaws in the SAT Report render it an ineffective decision-making tool for use in the MLPA process. In light of these flaws, we request that the SAT Report be immediately removed from the MLPA website until the Report can be revised so that it is consistent with current scientific studies. We also request that you require that the SAT Report be revised, as expeditiously as possible, to eliminate these numerous errors. Finally, in order to prevent similar problems in the future, we urge you to include California's shellfish growers as stakeholders in the MLPA process. We look forward to discussing these requests with you when we meet on March 17, 2008.

I apologize in advance for the length of the attached document. As you will read, there is a great deal of scientific research related to the environmental effects of shellfish culture, most of which was not considered by the authors of the SAT Report. Indeed, while the scientific record is replete with examples of environmental benefits from shellfish farming, not a single such benefit is mentioned in the SAT Report. In order to ensure that the scientific record is complete, we have endeavored to address as much of the relevant scientific literature as possible in this document.

Thank you for your serious consideration of these requests. We look forward to meeting with you on March 17.

Sincerely,

Robin Downey  
Executive Director

Response to SAT Report  
Response to the “Potential Impacts of Mariculture Activities in the MLPA North Central  
Coast Study Region” (revised January 4, 2008)

Prepared by Dr. Jeffrey P. Fisher,  
ENVIRON International Corporation  
Seattle, Washington

## **I. Introduction**

The Pacific Coast Shellfish Growers Association has requested this response document to address the deficiencies in the MLPA Science Advisory Team (SAT) Report, “Potential Impacts of Mariculture Activities in the MLPA North Central Coast Study Region.” This document addresses nine categories of alleged impacts from shellfish farming, including:

(1) water quality and habitat benefits provided through shellfish farming, (2) interactions between eelgrass and other habitat features with shellfish culture operations, (3) habitat value of shellfish beds, (4) interactions with sediment depositional features and sediment quality, (5) effects on birds and marine mammals, (6) the use of treated wood, (7) shellfish aquaculture gear as substrates, (8) non-indigenous species, and (9) human disturbance factors. In addition, clarifications are provided regarding several of the erroneous descriptions presented in the SAT report related to specific farming operations in California.

A vast library of information on the interactions of shellfish farming and the environment has been assembled by Environ, which has been engaged for several years in researching the environmental effects of shellfish aquaculture on the environment. Primary source references listed here can be made available upon request.

## **II. Analysis Ignores Benefits to Ecological Functions, Water Quality and Habitat Provided Through Shellfish Farming**

Public health standards for shellfish aquaculture demand clean waters. Commercial shellfish harvest can only take place in waters that have been certified under the National Shellfish Sanitation Program (NSSP), a stringent set of standards adopted by all shellfish producing states and operated under the Food and Drug Administration. These standards include monitoring for fecal coliform bacteria (which is used as an indicator for human activity and the potential for pathogens in the water), Vibrios, harmful algal toxins, heavy metals and other contaminants. The NSSP standards fostered the first estuarine/marine monitoring programs, and are the most stringent of all water quality classifications, far exceeding those required for swimming. Thus, shellfish growers are fundamental stakeholders in how coastal waters are regulated, and have, it could be argued, the most at stake in the preservation of clean water. In turn, the culture of shellfish facilitates the preservation of clean coastal waters through the filtration of these waters that is conducted by the shellfish themselves. Yet neither this benefit, nor many of the other beneficial ecological services provided by shellfish cultivation, is recognized by the SAT. The benefits of shellfish culture on water quality are broadly recognized by government and non-governmental organizations alike, as indicated in the following quotes:

*EPA notes that mollusks are filter feeders and, in some cases, are recommended not only as a food source, but also as a pollution control technology in and of themselves. Mollusks remove pollutants from ambient waters via filtration.*

- U.S. Environmental Protection Agency, 57 Fed. Reg. at 57,885 (September 2002)

*Since shellfish increase water quality and improve food production, we believe that there is generally a net overall increase in aquatic resource functions in estuaries or bays where shellfish are produced.*

- U.S. Army Corps of Engineers, 72 Fed. Reg. at 11,144 (March 2007)

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*Nutrient over-enrichment is a significant problem for the coastal regions of the United States.... Benthic filter feeders such as oysters, mussels, and many species of clams can have a major influence on phytoplankton populations in coastal waters.*

- National Research Council, the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering. 2000. Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution. National Academy Press, Washington, DC.

*One type of aquaculture - mollusk farming – actually reduces nutrient pollution.... Because 35-40% of the total organic matter ingested by a mollusk is used for growth and permanently removed by harvest of the mollusk.*

- Environmental Defense. 1997. Murky Waters: Environmental Effects of Aquaculture in the US. New York, New York.

*Filter-feeding mollusks can clarify the water by consuming plankton in aquatic systems, significantly improving water quality. Mussel farms can remove nitrogen from water at a 70% higher rate than occurs in surrounding waters. . . . Moreover, shellfish farmers are often among the loudest advocates for clean water.*

- Pew Oceans Commission. 2001. Marine Aquaculture in the United States. Arlington, Virginia.

*In the text of the Clean Water Act, Congress plainly and expressly listed the ‘protection and propagation of... shellfish’ as one of the goals of reduced pollution and cleaner water.”*

- United States Court of Appeals for the Ninth Circuit. APHETI v. Taylor Resources. 2002. Seattle, Washington.

*These filtering and recycling processes are critical in regulating the health of coastal ecosystems. The processes take on even greater importance as human activities and related pollution discharges increase in shoreline areas. The processes help counteract the potentially damaging effects of excessive nutrient enrichment of coastal waters, a process known as eutrophication.*

- Puget Sound Action Team. July, 2003. Keystone Species of the Estuary – Bivalve Basics. Olympia, WA.

*Oysters are extremely well-suited to aquaculture or ‘fish farming,’ and, because oyster farming can actually benefit the surrounding coastal waters, the risk of pollution and habitat effects is minimal. . . . Because they are filter feeders, oyster aquaculture facilities generally improve coastal water conditions by converting nutrients and organic matter to biomass.*

- Monterey Bay Aquarium Seafood Watch Program, [www.montereybayaquarium.org/cr/SeafoodWatch](http://www.montereybayaquarium.org/cr/SeafoodWatch)

In spite of this widespread recognition of the benefits of shellfish farming, the SAT Report fails to recognize even a single benefit from the cultivation of mollusks. Instead, the SAT Report focuses exclusively on allegations of negative environmental effects, many of which are unsupported, outdated, or irrelevant because of the ignorance of the beneficial ecological functions provided or the changes already made in industry practices. For that reason alone, the SAT Report should be revised.

### **III. The Allegations of Environmental Harm Discussed in the SAT Report are Contrary to the Scientific Record.**

The discussion of shellfish mariculture is found on pages 15 through 16 and 54 through 58 of the SAT Report. That discussion alleges a number of negative environmental effects from shellfish farming. Each of those allegations is addressed separately in the sections that follow.

#### *A. Eelgrass Interactions.*

The SAT Report claims that oyster mariculture operations negatively impact eelgrass. SAT Report at 55. That conclusion ignores the numerous scientific studies showing positive and/or benign relationships between

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eelgrass and shellfish culture. In addition, by ignoring the habitat value provided by the shellfish culture itself, the SAT Report fails to consider the beneficial habitat effects of shellfish culture.

### 1. Eelgrass and Shellfish Interactions.

It is not surprising that shading underneath shellfish culture gear has been found to reduce eelgrass growth in some studies. (Wechsler, 2004, and Rumrill and Poulton, 2004). However, numerous scientific studies have also shown that the overall effect of shellfish culture on eelgrass, from an estuary-wide perspective, is positive. The studies, discussed in detail below, were simply ignored by the SAT Report.

Filter feeders (e.g. oysters) consume water-column phytoplankton and particulate organic matter that can interfere with light penetration required for eelgrass photosynthesis (Best et al 2001, Koch and Beer 1996). The nutrient cycling aspects of shellfish populations may be a significant element in maintenance and growth of eelgrass communities in estuarine ecosystems. Eelgrass growth is likely accelerated in areas where the plants are co-mingled with bottom-growing shellfish (Newell 2006).

In Florida seagrass (*Thalassia testudinum*) beds, mussels (*Modiolus americanus*) enhance seagrass productivity (Peterson and Heck, 2001). Mussel excreta increase porewater nutrient concentrations, an effect associated with increased nitrogen and phosphorus content in seagrass blades, leading to faster growth. A similar study in southern California examined interactions between eelgrass (*Zostera marina*) and an introduced mussel (*Musculista senhousia*) (Reusch and Williams, 1998). Mussels were placed in eelgrass beds and near eelgrass transplants at several densities. At high densities, mussels inhibited rhizome extension of eelgrass, but across a range of densities, eelgrass blade growth rates increased.

Filter feeders also consume water-column phytoplankton and particulate organic matter that can interfere with light penetration, required for eelgrass photosynthesis (Best, et al. 2001, and Koch and Beer, 1996). The nutrient cycling aspects of shellfish populations may be a significant element in maintenance and growth of eelgrass communities in estuarine ecosystems.

One additional example of the interaction between oyster culture and eelgrass can be gleaned from a marine habitat mapping study recently completed at Bahía San Quintín, Baja California del Sur, Mexico. Bahía San Quintín is one of the foremost seagrass areas in western North America. Estimates of total extent of eelgrass range from 2,069 ha to 2,390 ha. Satellite (SPOT, and Landsat 5 and 7) imagery was used to track long term changes in eelgrass distribution in a portion of the bay with recently expanded oyster operations (Ward et al., 2003). Oysters were grown on 3 to 6 ft high by 3 to 6 ft wide plastic or wooden racks that were fixed to the bottom in low intertidal to shallow subtidal areas. Each rack consisted of a series of evenly spaced poles upon which bundles of oysters were suspended on lines. Racks varied in length (30 to 1,800 ft long) and spacing (3 to 200 ft apart), and were generally located close to main channels to maximize tidal flow through the oysters. Eelgrass comprised 49% (5,906 acres) and 43% (5,113 acres) of the aerial extent of the bay in 1987 and 2000, respectively. The authors attributed the reduction in subtidal eelgrass coverage between these years to sediment loading and turbidity caused by a severe flooding event in the winter of 1992–1993. The authors noted that oyster farming was not associated with any detectable loss in eelgrass spatial extent, despite the increase in number of oyster racks from 57 to 484 over the study period. On the contrary, there was an apparent gain in eelgrass coverage in oyster culture areas, and a small loss outside these areas, with the data showing no significant impact on eelgrass distribution from oyster racks.

The results of the Mexico rack and bag study are borne out by Wechsler's work in Drakes Estero. The SAT Report cites Wechsler's work as support for its conclusion that oyster culture negatively impacts eelgrass habitat. But while Wechsler acknowledges that eelgrass growth is restricted directly beneath oyster racks his

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ultimate conclusion is: “A qualitative look at the distribution of eelgrass beds in Schooner Bay indicated that its productivity was not affected substantially by oyster mariculture.” Wechsler (2004) at 29. Indeed, Wechsler himself notes the positive effect shellfish culture can have on eelgrass growth: Alternatively, Peterson and Heck (1999) suggest that because biodeposits from bivalves are high in nitrogen and phosphorus, organic enrichment from biodeposition can enhance growth of aquatic macrophytes, specifically eelgrass and Kelp. *Id.*

There is also a great deal of anecdotal evidence from shellfish growers supporting the hypothesis of a mutualistic relationship between oyster culture and eelgrass. Many growers, including growers in Tomales Bay, have located shellfish culture gear in areas devoid of eelgrass only to see eelgrass move into the culture area after shellfish seeding.

### 2. The Habitat Value of Shellfish Culture.

As noted in the SAT Report, one of the reasons that eelgrass is protected is that it provides important habitat for many marine species. What the Report fails to recognize is that shellfish culture similarly provides structured habitat that is beneficial to various species of fish and shellfish.

The Wechsler Study referenced in the preceding section (and cited in the SAT Report) found that the oyster culture areas in Drakes Estero demonstrated these positive habitat effects:

Coen, et al (1999) classified oyster reefs as Essential Fish Habitat (EFH), defined by the National Marine Fisheries Service as “those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity” (<http://www.nmfs.noaa.gov>). In Drakes Estero, the wooden support structures, oyster cultch and developing oysters may mimic the role of natural oyster beds by providing physical habitat, feeding opportunities, and cover for fish and invertebrates (Wechsler 2005).

Similar habitat benefits have been documented in other west coast estuaries. Ground cultured oysters provide habitat for an equally diverse community of macro-infauna as eelgrass in Willapa (Ferraro and Cole 2006). This is presumably due to the presence of oysters which can be considered ecosystem engineers and is the reason that these communities were more diverse than those found in the presence of other engineers like burrowing mud and ghost shrimp. Trianni (1996) and Rumrill and Poulton (2004) found higher benthic infaunal abundance and diversity in eelgrass than in oyster culture habitats in Humboldt Bay, California (the former study comparing dredge harvested on bottom oyster culture and the latter long-line oyster culture with eelgrass). Ground cultured oysters and shell placed in the intertidal portion of West Coast estuaries have been shown to provide equal or better habitat than eelgrass for juvenile 0+ Dungeness crab and both of these structures provide much better habitat than open unstructured mud or sand habitats where juvenile crab do not find adequate protection from predators including fish and larger crab (Eggleston and Armstrong 1995; Feldman et al. 2000). Older age classes of Dungeness crab (1+ and 2+ animals) however favor open unstructured littoral habitats for foraging and do not necessarily utilize structured habitat (Holsman et al 2006).

Habitat values were investigated by Ferraro and Cole (2001) for eight estuarine intertidal habitats in Willapa Bay, Washington, and Tillamook Bay, Oregon. It was determined that, on average, the rank order of habitats based on number of species present was oyster = *Zostera japonica* > *Z. marina* > *Upogebia* > *Spartina* > sand = mud = *Neotrypaea* = subtidal, undredged. Similarly, habitat rank for benthic macrofauna in terms of mean number of species, abundance, and total biomass was oyster = *Z. marina* > *Spartina* > *Upogebia* > mud > *Neotrypaea* > subtidal in Willapa Bay and *Z. japonica* > oyster > *Upogebia* > *Z. marina* > mud > *Neotrypaea* > sand > subtidal in Tillamook Bay (Ferraro and Cole 2003). In other words, the habitat value of oyster culture areas was equal to that of eelgrass beds.

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In a different study, researchers in Willapa Bay, Washington, sampled nekton (fish, crab, and shrimp), epibenthic meiofauna, and benthic macrofauna over intertidal eelgrass (varying densities), oyster beds (both bottom-culture and long-line), and un-vegetated mudflat. The role of habitat structure in determining the distribution and composition was found to vary for those three groups of animals. The spring and early summer coincided with a marked increase in the abundance and diversity of juvenile nekton that utilized shallow-water estuarine habitats as a nursery ground. The amount of prey resources for nekton was much higher in eelgrass meadows or on oyster beds (bottom culture) compared to mudflat and the diversity of nekton was qualitatively higher in oyster and eelgrass as well. Values of nekton diversity appeared more stable at oyster sites as lower diversity values were noted over eelgrass and mudflat in early spring and early summer (Hosack, 2003). These data suggest that both bottom-culture and long-line oyster beds provide foraging resources comparable to those afforded by eelgrass beds.

In terms of salmon habitat, Magnusson and Hilborn (2003) assessed the survival of coho and fall chinook salmon released from U.S. Pacific coast hatcheries with respect to three estuarine characteristics. The three characteristics were size of the estuary, the percentage of the estuary that is in natural condition and the presence of oyster culture in the estuary. The results suggested that oyster culture was not adversely impacting on salmon survival in estuaries where there were substantial runs. Willapa Bay, which has a 150+ year history of extensive oyster culture in dense eelgrass beds, had the highest coho salmon survival. Grays Harbor, also an important oyster farming estuary, had the third highest coho survival of the twenty estuaries included in the study. Despite (or perhaps because of) the large number of oyster cultivation operations in Willapa Bay and Grays Harbor (over 20% of the oysters consumed in the U.S. are grown in Willapa Bay), these Washington estuaries have some of the best coho salmon survival among the areas examined. Willapa's chinook salmon survival rate was 1.1% for the 898 coded wire tag groups assessed. Grays Harbor chinook salmon survival was slightly below the 20-estuary average at 0.8%.

A 2004 study published in *The Journal of Shellfish Research* also investigated the habitat value of shellfish aquaculture gear in comparison to eelgrass and non-vegetated areas. Abundance of marine organisms and species diversity was used to compare habitat value. The study indicated that aquaculture gear provides habitat for many species throughout the year in contrast to the seasonal nature of eelgrass and that species abundance and richness was higher during all times of the year; while species diversity was also higher but not significantly so in aquaculture gear as compared to eelgrass. Habitat value for both aquaculture gear and eelgrass were significantly higher than non-vegetated areas. The study concluded, "shellfish aquaculture gear has substantially greater habitat value than a shallow non-vegetated seabed, and has habitat value at least equal to and possibly superior to submerged aquatic vegetation." (Dealteris et al., 2004).

A 2004 study in Humboldt Bay, California, found that the "overall similarity of the invertebrate communities among the oyster longline and eelgrass reference sites provides evidence that oyster long line culture activities are not particularly stressful to the benthic infaunal communities of Arcata Bay" and that "there were only negligible changes in the overall composition of invertebrate communities." This study went on to find that the highest invertebrate biomass was found in oyster longline sites and that more species were present in eelgrass and oyster habitat than in open mud. (WRAC 2004)

A USFWS-sponsored study of the fish community in longline oyster culture areas of Humboldt Bay, California (Pinnex, et al, 2005) found a total of 49 species of fish. The study found significant differences between mudflat, eelgrass, and longline oyster culture habitats. Oyster culture areas had significantly greater catch per unit effort than mudflat or eelgrass areas. Oyster and eelgrass areas showed significantly higher species richness and diversity than mudflat areas.

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These scientific studies indicate that, even if some amount of eelgrass is displaced by shellfish culture gear, the habitat value of that eelgrass is at least replaced by the habitat value of the culture gear, resulting in no net loss of habitat value. Fishes may be responding to the structures as refuge from predation, and/or to increased feeding opportunities from a more diverse food assemblage generated on the aquaculture gear. It can be posited that the benefits from the structured habitat created for fish from the gear is likely a combination of both mechanisms: decreased predation risks and increased foraging opportunities. With respect to California operations, it is important to note that much of the oyster aquaculture in Tomales Bay and Drakes Estero is occurring (or was occurring, when originally planted) in areas that are currently non-vegetated. The scientific evidence discussed above fully supports a finding that oyster culture in these non-vegetated areas produces a substantial increase in habitat value. As such, the overall effect of shellfish culture in these estuaries represents an increase in habitat functions and values for a variety of fish species.

### *B. Effects on bottom sediments.*

The SAT Report also indicates that bivalve farming “creates anoxic conditions.” SAT Report at 55. The authority cited for this claim is a 2007 report authored by John Dixon of the California Coastal Commission. However, a cursory review of the cited report reveals that the statement regarding the creation of anoxic conditions is based on pure speculation:

“The [oyster] bags that are left on the intertidal flats **probably** add nutrients to the sediments and isolate the sediment from the water quality. Taken together, these factors **probably** result in anaerobic conditions developing closer to the surface, which **would likely** result in changes to the composition of the infaunal community.”

(Dixon 2007; emphasis added).

I am not aware of specific studies that have examined the anoxia question as it relates to the use of on-bottom bag culture. All shellfish (i.e., not the inert bags per se), whether wild stock or commercially cultivated, produce feces and pseudofeces. These end products reflect the coupling of benthic and pelagic water column processes that are fundamental to the maintenance of sediment quality and a healthy benthic infauna. (When the shellfish filter out the phytoplankton from the water column, they produce feces and pseudofeces that in turn support the base of the food web for detritivores resident as sediment infauna). In some studies, changes in sediment chemistry and nutrients have been documented in intensively cultured shellfish areas, relative to uncultured reference areas (e.g., Asami et al. 2005), but such changes do not necessarily translate to impacts to the benthic infaunal community. As practiced, oyster growers regularly and routinely cycle the oyster bags, and flip them to ensure that sediment anoxia does not become problematic. Failure to regularly cycle the bags could result in smothering of the oysters, and the possibility of highly localized sediment enrichment under the bags, which could reduce growth rates from the increase in biological oxygen demand at the sediment interface. It is in the farmers’ best interests to regularly maintain their bag culture operations to minimize the potential growth-inhibiting effects of sediment-associated anoxia. Thus, while sediment changes relative to reference areas without shellfish may be measurable in some instances, best management practices and culture densities will minimize these impacts to a biologically insignificant level at the basin scale where farm operations are located in California.

C. *Alteration of sediment deposition patterns*

The SAT Report also claims that shellfish farming negatively effects sedimentation and scour patterns and alters sediment nutrient content through biodeposition. SAT Report at 55. Again, these allegations of effect lack any scientific basis, at least as it relates to the shellfish culture densities seen in California's estuaries.

With regard to sedimentation and scour patterns, shellfish culture may exert a localized affect on water sediment distribution and tidal circulation within the immediate area of the culture plot. As water flows through the culture apparatus, it is slowed by the frictional effects of the culture gear. However, observations by growers indicate that sediment accumulation is minimal, and when sediment does accumulate, relatively common storm events generate wind driven currents that redistribute the accumulated sediments. Wind generated waves re-suspend the sediments, which are then transported and redistributed by tidal and wind generated currents (Barnhart et al. 1992).

Indeed, the oyster industry has recorded little or no sediment deposition associated with large-scale growing operations in Willapa Bay and Totten Inlet in Puget Sound, where operations have been continuous for over 100 years. Willapa Bay experiences high natural sediment loads and moderate wave energies. Sediment deposition tends to follow a seasonal pattern with increased but modest sedimentation during summer to fall followed by erosion and redistribution of sediments during winter to spring. The observations from Willapa and other estuaries indicate an absence of any significant sedimentation or circulation effects from longline culture. It is possible that short-term sediment accumulation may occur in the intervals between events generating enough energy for sediment redistribution. The consequences of short-term sediment accumulation are unlikely to be significant given that the organisms present have evolved in conditions that include the larger sediment redistribution events.

Indeed, during the Environmental Protection Agency's (EPA) rulemaking process regarding the final rule for effluent limitations guidelines for aquaculture activities (40 CFR 451, Aug 23, 2004) the EPA responded to comments on the issue of sediment accumulation stating "Two comments indicated that adverse environmental effects, primarily accumulation of silt and solids, of excessively large and densely seeded molluscan shellfish operations were reported in the scientific literature (e.g., DCN 70270, 70511). However, these sources acknowledge that adverse impacts are unusual and have not been reported in the United States." In a review of literature for west coast estuaries, limited sediment accumulation has been observed; however, no adverse effects have been documented.

With regard to changes in sediment nutrient content through biodeposition, several researchers have shown that filter feeding bivalves can have the effect of essentially fertilizing estuarine sediments, which can benefit maintenance and growth of eelgrass communities. Eelgrass can derive nutrients from both the sediments and the water column. However, the interstitial water contains relatively higher concentrations of dissolved inorganic and organic nutrients than the water column. Therefore, eelgrass obtains most macronutrients from sediments. Sediment reservoirs of nutrients can become depleted when biogeochemical regeneration rates cannot meet plant demands (Short 1983 and 1987). However, in the course of removing water column particulates, filter feeders also alter sediment characteristics. Filter feeders consume water-column phytoplankton and particulate organic matter that can interfere with light penetration, required for eelgrass photosynthesis (Best et al. 2001, Koch 2001). Pseudofeces and feces produced by bivalves can increase both sediment organic content and nutrient levels in sediment porewater (Reusch and Williams 1998) and (Peterson and Heck 2001).

Researchers at a western Baltic study site reported sediment porewater concentrations of ammonium and phosphate doubling in the presence of mussels (*M. edulis*). There was a strong correlation between porewater

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ammonium concentration and plant size. *M. edulis* was believed to facilitate native eelgrass (*Z. marina*) by the biodeposition of organic material via feces and pseudofeces. Plants in a mussel addition treatment had a 36 % higher leaf area than the controls, whereas mussel removal led to an area decrease of 16 % compared to the controls (Reusch, Chapman and Groeger 1994).

In short, the breadth of the scientific record does not support the conclusion in the SAT Report that shellfish culture negatively affects sediment deposition patterns or sediment quality. Indeed, studies actually show that shellfish are more likely to have a positive influence on sediment quality, (e.g., increased eelgrass growth from sediment fertilization). The references that are cited in the SAT report are all from foreign studies, where the densities of cultured product, the geomorphology of the water-body in which the animals are cultured, and the culture methods differ. For example, in the De Casabianca study cited by the SAT, the authors evaluated sediment quality characteristics in a relatively enclosed lagoon system off the coast of France, where oyster and mussel ‘table culture’ (presumed racks) occupies a minimum of 20 percent of the lagoon area. While they found evidence of sedimentation attributed to the oyster culture operations, it should be recognized that the scale of the culture operations exercised in the Thau lagoon far exceeds that of shellfish farms in California. Similarly, in the Bertin and Chaumillon (2006) study cited by the SAT, oyster farming is identified as a source of sedimentation to the embayment study area. In this latter case, the study area was highly enclosed, and is very intensively cultivated, as reportedly the first European domain where the commercial culture of oysters was initiated. We do not dispute their data, but must point out that site selection practices of today’s industry would be unlikely to permit such high density culture in an embayment with naturally poor circulation. We do not contend that sediment deposition and quality will not change in areas where shellfish are cultured, even in California, rather that drawing conclusions that the change in sediment deposition is inherently negative for California’s waters where shellfish are cultured is simply not supported by any local studies of which we are aware.

### *D. Effects on Birds and Marine Mammals.*

The SAT Report also alleges that shellfish farming negatively impacts birds and marine mammals. SAR Report at 55. With regard to impacts to foraging birds, the scientific record does not support a conclusion that shellfish farming negatively impacts bird use. With regard to marine mammals, the SAT Report’s conclusion of interference with haul-out is inconsistent with the factual record.

The collective evidence from a variety of shore and seabird species evaluated suggests shellfish culture does not create a significant negative impact on bird use. Where impacts have been observed, they have either been positive - increasing avian species richness and abundance due to increased forage opportunities - or benign, eliciting no significant difference in use from natural beds. Anecdotal evidence from shellfish growers supports this conclusion.

Shellfish, whether cultured or wild, form an important source of food for a wide variety of marine shorebirds (Dankers and Zuidema 1995; Norris et al. 1998; Hilgerloh et al. 2001; Lewis et al. 2007). Through their foraging habits, migrating marine shorebirds can significantly alter the community structure of wild bivalve populations in soft-bottom intertidal areas (Lewis et al. 2007). At shellfish aquaculture sites, some species of marine shorebirds feed directly on the shellfish products themselves (e.g., Dankers and Zuidema 1995), while others feed on the macrofauna and flora that colonize shellfish aquaculture gear (e.g., Hilgerloh et al. 2001).

Connolly and Colwell (2005) reported that seven of 13 marine shorebirds and three of four wading birds were more abundant on oyster longline plots compared to reference sites. Although marine shorebirds feed at shellfish aquaculture sites, Hilgerloh et al. (2001) found that the aquaculture sites themselves did not necessarily

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attract larger numbers of birds than non-cultured areas. For instance, Zydelis et al. (2006) found that natural environmental attributes were the primary determinants of densities of wintering surf scoters and white-winged scoters in Baynes Sound, B.C. Moreover, the authors found that shellfish aquaculture variables did not necessarily predict bird densities for both scoter species. According to Zydelis et al. (2006), these findings suggest that winter scoter populations and the shellfish aquaculture industry may be mutually sustainable. In other words, there was no evidence of a negative impact on winter scoter populations at the current level of shellfish farming practiced in Baynes Sound, B.C. Indeed, Connolly and Colwell (2005) found that shellfish aquaculture in Humboldt Bay, California did not negatively affect the foraging behavior of most marine shorebirds studied.

Finally, while Kelly et al. (1996) point out that sandpipers and dunlins may be reduced in areas occupied by mariculture bags, they are clearly not excluded or eliminated from these areas, and in fact, the same author points out in a later publication (Kelly 2001) that the bags are used by shorebirds. Thus, habitat use for some shorebird species may be modified, but the evidence is far from conclusive that this impact is negative and could be argued to be positive, as roosting habitat is more likely a limiting factor for these birds than open mud flats.

With regard to marine mammals, shellfish growers do not place shellfish aquaculture gear in marine mammal haul-out areas. There have been instances where marine mammals have used a shellfish farming area for haul-out after a farm has been established, but such use does not show that shellfish farming interferes with marine mammal haul-out. Quite the opposite -- marine mammals use of shellfish areas for haul-out shows that the shellfish farming equipment does not present an impediment to haul-out.

### *E. Use of Treated Wood for Oyster Racks*

The SAT Report also criticizes shellfish farmers for using treated wood for construction of oyster racks. However, the only racks in the North Central Coastal area that use treated wood are historic racks that are in place in Drakes Estero, and in fact, Drakes Bay Oyster Company, the shellfish farm in that estuary, is currently in the process of phasing those racks out of use. Once that phase-out is complete, there will be no treated wood associated with shellfish farming in the North Central Coast.

### *F. Creating Hard Substrate*

The SAT Report also notes that shellfish culture gear creates a hard substrate. SAT Report at 56. In Section II.A.2., above, we have provided citations to the numerous scientific studies documenting the habitat value provided by shellfish culture gear. While ignoring these habitat benefits, the SAT Report complains that the oyster gear can also provide habitat for non-indigenous species. While that is a possibility, the same can be said for any structured habitat, such as reefs, gravel, rocks or other such material. As to whether such an impact is “significant,” the Dixon report, which appears to be the basis for much of the SAT Report, itself acknowledges that a significant impact is unlikely. (Dixon 2007 at 6 notes that *Didendum*, the non-indigenous species referenced in the SAT Report, is unlikely to become a problem in Drakes Estero).

It is worthwhile to consider the hard substrate created by aquaculture gear in the MPLA context as well. For example, in Puget Sound and elsewhere, the addition of structured habitat, artificial or otherwise, to homogenous marine habitats like sand and mud, has long been recognized to increase the types and numbers of colonizing fish, invertebrates, and aquatic plants in a given area (Iversen and Bannerot 1984; Buckley and Hueckel 1985; Hueckel and Buckley 1987; Gregg 1995; Sargent et al. 2006). For example, Buckley and Hueckel (1985) examined the sustained aggregation of recreationally important fishes in an artificial reef

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placed on a sandy bottom off Gedney Island, Washington, and examined the rate of development towards a natural temperate reef. In addition to a sustained aggregation of non-game prey fishes, primarily shiner and striped perch (Embiotocidae), they found that anglers fishing over the reef structure retained more than twice the number of fish per hour than anglers fishing nearby natural waters without the structured habitat. They surmised that the increase in recreationally important fishes was the result of successional biota (e.g., algae and sessile invertebrates) colonization and development on the reef structure that provided an alternative prey source when other normal forage fish were in cyclic low abundance. Such reef structures also provide refuge from predation and the enhancement of the availability of food for other marine organisms of no recreational interest—thereby enhancing local biodiversity (Hueckel and Stayton 1982; Hueckel and Buckley 1987). When the habitat provided by such reef structures is otherwise limited in the water body, artificial reefs can result in sustained population increases in recreationally and commercially important fisheries resources through their ultimate effects on the viability of individuals within a broader population. This “halo effect” underpins, in large measure, the initiative behind ‘marine protective areas’ to enhance fishery resources throughout the World Ocean today.

Like artificial reefs composed of concrete blocks, metal lattices, sunken vessels, etc., several studies have shown that the gear associated with shellfish aquaculture provides the basis for similar ‘biogenic’ habitat services and ecological benefits. For example, Laffargue et al. (2006) demonstrated that the flatfish, *Solea solea*, displays a strong affinity for oyster-rearing structures when resting or seeking refuge during the day. Tallman and Forrester (2007) showed that oyster grow-out cages provided valuable habitat for economically valuable finfishes in Narragansett Bay, Rhode Island and suggested that these structures be considered as part of future habitat restoration programs for the exploited species. Likewise, Meyer and Townsend (2000) showed that created oyster reefs had a higher number of fish and molluscan and crustacean invertebrate species than adjacent natural reefs. O’Beirn et al. (2004) reported a wide variety and large number of marine organisms associated with the mesh bags of cultured oysters in Virginia. These included worms, mollusks, crustaceans and fish. And finally, Powers et al. (2007) documented that the macroalgal growth on protective netting placed over hard clam (*Mercenaria mercenaria*) aquaculture sites supported elevated densities of mobile invertebrates and juvenile fishes similar to natural seagrass (*Z. marina* and *Halodule wrightii*) habitats.

### G. *Non-indigenous Species.*

The SAT Report also notes that, historically, shellfish imported from Japan and Europe have been the source of introductions of non-indigenous species. SAT Report at 56. While this may have been true historically, the SAT Report fails to acknowledge that current regulations and culture practices have virtually eliminated shellfish farming as a pathway for introductions of non-indigenous species.

All shellfish seed imported into California must be certified disease free and regulated by the CDFG by an importation permit. All of the seed comes from hatcheries in Washington and Oregon; growers no longer import wild seed from Japan or Europe. The seed is routinely inspected via histological and PCR inspection and certified free of disease by a USDA/APHIS certified veterinarian. CDFG carefully monitors hatchery and seed production facilities in Washington and Oregon. It requires these facilities to submit seed inspection reports on a regular basis, and routinely conducts seed inspections and histopathological analysis on imported seed. CDFG only allows importation of seed from established hatcheries with a minimum two-year history of documented absence of disease. The certification process includes inspection of larvae and seed for disease, parasites and invasive/exotic species. It also includes regular communication with Washington and Oregon State biologists and regulators to maintain open communication about relevant issues. In view of these precautions, and shellfish growers ongoing interest in keeping their growing waters free of hazardous exotic species, current shellfish farming practices pose little risk of causing new introductions of invasive or exotic species.

*H. Effects of Human Disturbance*

Finally, the SAT Report raises issues related to “human disturbance” that occurs by virtue of shellfish growers working out in estuaries. The issues include potential disturbance of birds and mammals, “trampling” of the substrate associated with ongoing culture activities, and propeller scars from boat use. While there may be some potential for these effects, the actual impacts of these activities are minimal.

The activity that takes place in shellfish culture areas is fairly limited. There is some level of activity on a bed when seed are initially planted, after which there is a significant grow-out period (one to three years, depending on culture area and product) during which activity is minimal and entails an occasional (approximately monthly) inspection of the farm. After this grow-out period, there is a brief period of activity where product is harvested and the area is replanted, followed by another lengthy grow-out period. While the human activity at planting and harvest might have some short term impact, any such impact would be minimal considering the significant length of time during which shellfish are simply left to grow, with an occasional inspection.

**IV. The SAT Report Contains Erroneous Factual Information.**

In addition to the flaws noted above with regard to the SAT Report’s allegations of environmental harm, the Report’s description of culture practices is factually inaccurate. The following list highlights many of the factual errors that were readily apparent to California’s growers.

- *Pg. 55, top of page, statement that mussels “are not actively cultured” and sentences that follow:* These statements are incorrect. Mussels are actively cultured in Tomales Bay. Only one of the Bay’s mussel growers collects wild seed; two others buy seed and actively seed lines. All three of the Bay’s mussel growers farm using subtidal longlines.
- *Pg. 55, first full paragraph describing oyster culture methods:* 1) bags may also be placed on rebar or PVC racks, in addition to wooden racks. 2) oyster bags are never “scattered by hand haphazardly.” Bags maybe placed in intertidal areas at high tide, then secured onto lines or racks during low tide to keep gear from blowing away in storms. 4) Not all floating bags rest on mudflats at low tide. Some growers use floating trays/bags that are secured to floating longlines.
- *Pg. 55, second full paragraph:* Oyster racks are never placed in eelgrass beds. Growers’ leases include conditions that prevent growers from cutting or harming eelgrass plants. While oyster racks are never initially placed in existing eelgrass, it is the case that eelgrass has encroached into some rack and bag areas, which is consistent with the scientific findings of positive interactions between eelgrass and shellfish, as discussed in detail earlier.
- *Pg. 55, fourth full paragraph:* “[L]arge amounts of intertidal foraging areas” are not covered with shellfish cultivation. With regard to Tomales Bay, there are about 567 acres currently under lease. On the most highly productive leases, the maximum coverage (structures, bags) is approximately 50%. The coverage is much lower on most leases, as growers avoid eelgrass areas and leave boat channels for access. So the total potential area impacted by shellfish culture in Tomales Bay is significantly less than 280 acres – much of which is subtidal. Tomales Bay is about 11,000 acres in size total. Shellfish culture occurs on less than 2.5% of the estuary; the total potential area of impact is thus very small.

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- *Pg. 56, Table A:* “Scattered bags” is not a growing method used by any grower and should be removed from the table. In addition, the table contains the following inaccuracies:
  - o Charles Friend: The acreage in use is actually 15 acres. The cultivation method is longline bottom bags
  - o Hog Island Oyster Company: The total acreage is actually 160 acres. The cultivation methods include longline bottom bags and longlines (mussels).
  - o Pt. Reyes Oyster Company: The total acreage is actually 100 acres.
  - o Tomales Bay Oyster Company: On species cultivated, Europeans oysters are not cultured.
  - o Drakes Bay Oyster Company: On species cultured, add European oysters and purple hinged rock scallops.
  - o Need to add Marin Oyster Company: They lease 30 acres total, with 10 acres under cultivation. They grow Pacific oysters, Eastern oysters, Manila clams and mussels. Their cultivation methods are longline bottom bags, floating bags on longlines.

That a Report of this significance is so factually flawed reflects problems in the stakeholder process. Had California’s shellfish growers been actively included in the MLPA process, such serious flaws might have been avoided.

## V. Conclusion

The impacts of shellfish cultivation in estuaries in the North Central Coast must be considered in light of the six fundamental goals of the MLPA. As discussed in detail above, an appropriate scientific review reveals that shellfish farming helps to advance each of these goals:

**Goal 1: To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.** Shellfish farms help to increase diversity and abundance of marine life. The filtering function of shellfish helps to protect the integrity of marine ecosystems, particularly where those systems have been impacted by human development.

**Goal 2: To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.** Cultured shellfish are a species of significant economic value to the state of California and its growers. California is the second largest producer of farmed shellfish on the U.S. West Coast, with annual farm-gate sales averaging \$8.6 million.

**Goal 3: To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.** Shellfish farms help to maintain significant biodiversity and provide exceptional educational and study opportunities, as is evidenced by the significant number of studies referenced in this letter.

**Goal 4: To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.** Shellfish cultivation in California is a significant part of the state’s marine heritage. Shellfish farming has been occurring in the state for almost 100 years.

**Goal 5: To ensure that California’s MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.** As explained in great detail in this letter, one of the fundamental flaws with the SAT Report is that it is not based on sound science. Indeed, the Report itself ignores the significant body of scientific literature relating to the environmental interactions of shellfish farming on the environment. Any recommendation or decision based on the SAT Report will, therefore, be scientifically flawed.

**Goal 6: To ensure that the state's MPAs are designed and managed, to the extent possible, as a network.** Shellfish cultivation takes place in several of California's Northern estuaries, including Drakes Bay, Tomales Bay and Humboldt Bay. While each of these estuaries is unique, any MPAs in these areas should be designed and managed in a manner that recognizes the value of shellfish cultivation.